REMARKS

Reconsideration of this application, as amended, is respectfully requested.

THE CLAIMS

Claims 1 and 23 have been amended to clarify that the container is a sealed container, as supported by the disclosure in the specification at, for example, page 31, lines 14 and 15.

No new matter has been added, and it is respectfully submitted that the amendments to claims 1 and 23 are clarifying in nature. Accordingly, it is respectfully requested that the amendments to the claims be approved and entered under 37 CFR 1.116.

THE PRIOR ART REJECTION

Claim 1 was rejected under 35 USC 102 as being anticipated by US 2002/0081471 ("Keegan et al"); claims 1, 2, 4-9, 11, 12, 23 and 25 were under "35 USC 102(e)/103(a)" as being "anticipated" by USP 6,562,496 ("Faville et al"); claim 24 was rejected under 35 USC 103 as being obvious in view of the combination of Faville et al and US 2003/0015093 ("Wegeng et al"); and claims 10, 26 and 27 were rejected under 35 USC 103 as being obvious in view of the combination of Faville et al and US 2002/0110712 ("Struthers et al"). These rejections, however, are respectfully traversed.

According to the present invention as recited in amended independent claim 1, a reformer is provided which comprises a micro reactor comprising a flow path for a fluid; and a <u>sealed</u> container which accommodates the micro reactor and <u>keeps an atmosphere on a periphery of the micro reactor at a pressure of not more than 1 Pa</u>.

According to the present invention as recited in amended independent claim 23, a reformer is provided which comprises: a micro reactor comprising a flow path for a fluid; a <u>sealed</u> container which accommodates the micro reactor and <u>keeps an atmosphere on a periphery of the micro reactor at a pressure of not more than 1 Pa</u>; and adsorption means for adsorbing a medium which is present inside the container and which propagates heat.

It is respectfully submitted that the sealed container in which an atmosphere on a periphery of the micro reactor is kept at a pressure of not more than 1 Pa by the sealed container is a structural feature of the present invention which provides significant advantages to the reformer recited in claims 1 and 23 effects. And it is respectfully submitted that none of the cited references disclose, teach or suggest this feature of the claimed present invention.

More specifically, according to the claimed present invention, since a container accommodating a micro reactor is sealed at an extremely low pressure (not more than 1 Pa) and the

pressure of the atmosphere on the periphery of the micro reactor is maintained by the sealed container at 1 Pa or below, it is possible to reduce thermal loss of the micro reactor and to heat the micro reactor to a desired temperature with a small amount of heat.

The attached Reference Figure illustrates the relationship between the power consumption in operating a micro reactor of the present invention (longitudinal axis) and the pressure in the container accommodating the micro reactor (horizontal axis). The relationship shown in the Reference Figure was measured by accommodating the micro reactor shown in Fig. 5 of the present application in a container, and by measuring the electric power that was required to be supplied to a thin film heater to raise the temperature of the micro reactor to a predetermined operative temperature when various pressures were held steady in the container accommodating the micro reactor. At each pressure, the power required to maintain the temperature of the micro reactor at the predetermined operative temperature was calculated as the power consumption.

As can be understood from the Reference Figure, if the pressure inside the container is the same as atmospheric pressure (1.013×10^5 Pa), approximately 6.5W is required to maintain the operative temperature of the micro reactor in a steady state. Reductions in the pressure maintained in the container correspond

to reductions in the power consumption. And when the temperature in the container is held steady below 1 Pa, the power consumption is substantially constant at 3W.

Thus, the structure of the present invention as recited in claims 1 and 23, whereby the sealed container keeps an atmosphere on a periphery of the micro reactor at a pressure of not more than 1 Pa, corresponds to a specific advantage, namely fully reducing the power consumption for operating the micro reactor.

The differences in the power consumption at the various pressures shown in the Reference Figure correspond to leakage of heat (that is, thermal loss) in operating the micro reactor accommodated in the container. Thermal loss generally occurs due to the heat that leaks out of the container from the heated micro reactor by thermal conduction of solids and gases and thermal conduction in radiation. Of these causes, the thermal conduction of solids and the thermal conduction in radiation do not depend on the pressure inside the container. Examples of the thermal conduction of gases are thermal conduction due to convective flow, viscous flow, and molecular flow. Here, the thermal conduction due to convective flow should be considered only at the place which is under atmospheric pressure, in other words, it can be neglected in areas of low pressure (vacuum).

In the thermal conduction of gases, it is generally known that there are a viscous flow region that is independent of

pressure (region shown by α in the Reference Figure) and a molecular flow region that is dependent on pressure (region shown by β in the Reference Figure).

The viscous flow region (α in the Reference Figure) is a region having a pressure where a mean free path of a gas molecule (mean free path is a mean of a distance traveled by a certain molecule without colliding with other molecules, which is in inverse proportion to vacuum) becomes sufficiently short as compared to the characteristic length of a heating element (having the heat of substantially a predetermined amount which corresponds to the micro reactor that is heated to a predetermined temperature for reaction in the present invention). A molecule which has collided with the heating element and received heat therefrom is very likely to collide with the heating element again after it collides with ambient molecules. Thus, high temperature molecules stay around the heating element, thereby forming a temperature gradient. Thermal conduction occurs by the temperature gradient, and when the pressure increases, although a collision frequency of the molecules increases, gaseous thermal conductivity remains the same since the distance that the heat is conducted becomes shorter.

The molecular flow region (β in the Reference Figure) is a region having a pressure where a mean free path becomes sufficiently long as compared to the characteristic length of a

heating element. A molecule which has collided with the heating element and received heat therefrom will repeatedly collide with ambient low temperature molecules without colliding with the heating element again, to be in thermal equilibrium. The level of thermal conduction depends on the collision frequency of the molecules, and as the pressure becomes lower, the collision frequency of the molecules becomes lower, which causes the gaseous thermal conductivity to be reduced.

The present invention is focused on the thermal conduction discussed above, and according to the present invention the gaseous thermal conductivity is reduced by providing a structure in which the atmosphere in the container is at a pressure in the molecular flow region. Namely, with the structure of the claimed present invention, by providing the atmosphere at a pressure of not more that 1 Pa, which is kept by the sealed container, it is possible to reduce the thermal loss which occurs during gaseous thermal conduction.

It is respectfully submitted that none of the cited references disclose, teach or suggest the structure of the claimed present invention whereby an atmosphere on a periphery of a micro reactor is provided which is at a pressure of not more than 1 Pa, wherein the pressure of the atmosphere is kept at not more than 1 Pa by a sealed container which accommodates the micro reactor.

On page 1 of the Office Action, the Examiner asserts that Keegan et al discloses a "container/system enclosure (130 & 220" which accommodates the micro reactor and keeps an atmosphere on a periphery of the micro reactor at a pressure of not more than 1 Pa/(under vacuum)" at paragraph [0051].

It is respectfully pointed out, however, that while Keegan et al discloses controlling the pressure in the enclosure 130 using enclosure pressure control 150 that may comprise one or more of various mechanical devices, Keegan et al explicitly states that the enclosure 130 "generally may contain gases such as air, pure oxygen, inert gases or other suitable gas" (see paragraph [0051], lines 1 and 2).

It is respectfully submitted that the disclosure of paragraph [0051] of Keegan et al <u>clearly</u> does not indicate that the pressure in the enclosure 130 is not more than 1 Pa as suggested by the Examiner. Indeed, in the paragraphs following paragraph [0051] cited by the Examiner, Keegan et al discloses that the pressure in the enclosure 130 may generally be the same as the pressure in the stack 110, or the relative pressure in the stack 110 and enclosure 130 may be varied by the mechanisms 140 and 150 to set the pressure in the enclosure 130 to be higher than the pressure in the stack 110 (to prevent leaks from the stack 110 into the enclosure 130) or to set the pressure of the enclosure 130 to be lower than the pressure in the stack 110 (to

prevent leaks of air from the enclosure 130 to the stack 110). See paragraphs [0052] to [0057] of Keegan et al. See also paragraph [0060] and [0061] of Keegan et al, which relate to the relative pressure in the reformer 210 and enclosure 220.

It is respectfully submitted, however, that while Keegan et al discloses varying the relative pressures in the stack 110 and enclosure 130 and the relative pressures in the reformer 210 and the enclosure 230, Keegan et al does not disclose, teach or suggest providing a reformer in which an atmosphere on a periphery of a micro reactor at a pressure of not more than 1 Pa, wherein a sealed container, which accommodates the micro reactor, keeps the atmosphere on the periphery of the micro reactor at the pressure of not more than 1 Pa, in the manner of the present invention as recited in amended independent claims 1 and 23.

Indeed, it is respectfully submitted that Keegan et al merely discloses variably setting pressures in the stack 110 and reformer 210 and their respective enclosures 130 and 230 in accordance with the operation of the system of Keegan et al, so as to realize "various benefits," as recognized by the Examiner on page 7 of the Office Action. It is respectfully pointed out, however, that according to Keegan et al the "various benefits" correspond to relieving stresses on seals and preventing or minimizing leaks into and out from SOFCs and reformers, so as to enable the use of lower cost seals, prolong the life of the

seals, and provide more productive SOFC's, SOFC stacks, and reformers.

It is respectfully submitted that this disclosure of variously controlling pressure according to Keegan et al does not suggest providing a sealed container to keep an atmosphere on a periphery of the micro reactor at a pressure of not more than 1 Pa, in the manner of the present invention as recited in amended independent claims 1 and 23, by which structure thermal conduction of heat to the outside is suppressed, which is clearly not disclosed by Keegan et al.

On pages 2-3 of the Office Action, the Examiner asserts, that Faville et al discloses a "container/system enclosure 100 which accommodates the micro reactor 123 and keeps an atmosphere on a periphery of the micro reactor at pressure not more than 1 Pa/vacuum." In addition, the Examiner refers to the abstract of Faville et al to assert that, since Faville et al teaches different pressures within the container/enclosure, it "would be obvious that the container/enclosure (100) would inherently withstand and perform in vacuum."

It is respectfully submitted, however, that Faville et al clearly does not disclose, teach or suggest a reformer in which a sealed container accommodates a micro reactor and keeps an atmosphere on a periphery of the micro reactor at a pressure of not more than 1 Pa.

Indeed, it is respectfully pointed out that in order for the device of Faville et al to operate, the main blower 110 is provided to blow air into the enclosure 100, so as to pressurize the chambers 102, 104 and 106 to cool and purge the SOFC system. More specifically, Faville et al discloses a thermal management system (column 9, lines 10-47) in which a main blower 110 takes in air 103 and discharges the air into a main plenum chamber 102 and raise the pressure in the main plenum chamber 102 (column 3, lines 37-41, and column 9, lines 18-24, and FIG. 1). The pressurized air is supplied to an insulation plenum chamber 104 by an air control valve 160, and air is supplied through a porous insulation layer 105 to a hotbox 106 chamber in such a manner that the pressure P2 of the air flow through the insulation plenum chamber 104 is less than the pressure P3 in the hot box chamber 106. And the air in the hot box chamber is then exhausted to the exterior of the system via valve 107. (See column 9, lines 29-42).

It is respectfully submitted that the disclosure of blowing air into an enclosure to pressurize the chambers in the enclosure and then exhausting air out from the enclosure clearly does not correspond to a sealed container that accommodates a micro reactor and keeps an atmosphere on a periphery of the micro reactor at a pressure of not more than 1 Pa, as recited in amended independent claims 1 and 23.

In view of the foregoing, it is respectfully submitted that Keegan et al and Faville et al relate to variously controlling pressure in accordance with operation of a micro reactor, and it is respectfully submitted that neither of these references discloses, teaches or suggests the structure of the present invention whereby an atmosphere on a periphery of a micro reactor is provided which is at a pressure of not more than 1 Pa, wherein the pressure of the atmosphere is kept at not more than 1 Pa by a sealed container which accommodates the micro reactor, by which structure thermal conduction of heat to the outside is suppressed, in the manner of the present invention as recited in amended independent claims 1 and 23.

It is respectfully submitted, moreover, that the other prior art of record also does not disclose, teach or suggest the above described features and advantageous effects of the present invention as recited in amended independent claims 1 and 23.

Accordingly, it is respectfully submitted that amended independent claims 1 and 23, and claims 2, 4-11, and 24-27 respectively depending therefrom, all clearly patentably distinguish over Keegan et al and Faville et al, and all of the cited references, taken singly or in any combination, under 35 USC 102 as well as under 35 USC 103.

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Entry of this Amendment, allowance of the claims and the passing of this application to issue are respectfully solicited.

If the Examiner has any comments, questions, objections or recommendations, the Examiner is invited to telephone the undersigned for prompt action.

Respectfully submitted,

/Douglas Holtz/

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